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The Intellectual Standing of Charles Darwin, and the Legacy of the "Scottish Enlightenment" in Biological Thought

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ABSTRACT Charles Darwin is universally associated with promoting the concept of organic evolution, but there have been persistent currents of denigration and misunderstanding that began with his own contemporaries and continue to the present, prominently represented today in paleontology and especially in biological anthropology where he has been described as a dull, timid, and mindless collector of trivia—"blotting paper, soaking up life's ink." On the other hand, qualified analysts of literary style, philosophy, and the history of science have concluded, after careful analysis of his writings, that Darwin's contributions were of the highest caliber in each of the realms in question. His work was carried out with a full understanding of the highest standards of the thought and documentation of his intellectual predecessors and contemporaries. The significant roots of his orientation are to be found in the outlook of the Scottish Enlightenment. Just as the physical sciences represent a continuation at the professional level of "Scottish Realism," Charles Darwin should be seen as the means by which that orientation was projected into what has become the biological sciences. Yrbk Phys Anthropol 40:91–111, 1997.

DARWIN AND THE CONCEPT OF EVOLUTION

Despite all the qualifications and disclaimers, the outlook evoked by the word "evolution" is inextricably associated with the name of Charles Darwin. Curiously, it was a word not used in his justly acclaimed masterpiece, *On the Origin of Species by Means of Natural Selection, or, the Preservation of Favoured Races in the Struggle for Life,* to give it its full title (Darwin, 1859). An assessment of the treatment of evolution involves the appraisal of intellectual styles. The mere fact of evolution itself—"descent with modification," as Darwin phrased it in its most succinct form (Darwin, 1859:420)—is so banal and self-evident that it is simply the consequences of history perceived in the light of simple common sense. Thomas Henry Huxley exclaimed, "How extremely stupid not to have thought of that!" (Huxley, 1887: 551) when he first read Darwin's exposition of the concept and the idea of natural selection in *The Origin,* and we smile in a slightly condescending fashion as we recall the incident.

Consider the Tibetan parable concerning the durability of Mount Everest: "Chomolungma is the mightiest of mountains. Once in a thousand years, an eagle flies over its peak and brushes the crest with a single beat of its wing. When by the repetition of this process the mass of Chomolungma shall have been reduced to the level of the sea, there will have passed one second of eternity." We emulate Huxley as we nod appreciatively and ponder at the various ways in which the human mind can phrase the obvious. However, we know full well that even though mountains rise and are worn away by the accumulation of natural events, the abrasion produced by the feathers of a bird's

wing does not represent the principle causative mechanism.

Although Darwin had verbalized the picture of organic evolution in such a fashion that it seemed self-evident, Huxley never did come to grips with the full dynamics of Darwin's synthesis. This remains true for many right up to the present—including, curiously enough, the bulk of those who concentrate their professional efforts on the study of human evolution. In part, this is a matter of perspective. A human being is born, lives, and dies. Others go through the same cycle in unending repetition, and no two humans are exactly alike. Still, it is not clear from the vantage point of a single life, or even from the contemplation of what one knows of other lives, that there is any cumulative or permanent alteration in the nature of the cycle itself. It took Darwin to perceive that, in the long run, cumulative change was not only the norm, but that the discernible differences between all living species had been its natural consequence and that all living matter—all plants and animals—were descended from a single common form. Further, unlike the allegorical example of the actions of a hypothetical eagle feather, he worked out a plausible mechanism by which that picture of change could have been produced.

It was a breathtaking intellectual achievement, but it did not take place in a vacuum. Any number of critics have pointed to earlier formulations of the idea of evolution and then have denigrated Darwin for lack originality or failure to give credit to his predecessors (Butler, 1882; Zirkle, 1941; Barzun, 1958; Darlington, 1959; Himmelfarb, 1959; Bethell, 1976; Popper, 1978; Eiseley, 1979; Barham, 1995). The denigrations, however, are almost invariantly self-serving and designed to demonstrate the supposedly superior worth of the critic by demeaning the magnitude and nature of Darwin's accomplishment.

Yes, Democritus and Epicurus in classical Greece suggested that the world operates in a mechanistic and processual fashion as did their Roman follower, Lucretius, in the first century BCE. Yes, Buffon and Darwin's own grandfather Erasmus in the 18th century and Lamarck just before Darwin's birth linked manifestations of organic form to environmental differences, and their views were all transmitted to Darwin as part of his general educational background. But then, knowledge of water power, the wheel, and the principles of mechanics was widely distributed across the Old World. As the late Joseph Needham has so abundantly shown, all the essential pieces were available in China as far back as anywhere else and yet, for reasons that are still somewhat obscure, the industrial revolution and its consequences first took place in a restricted portion of northwest Europe (Needham, 1969).

A good case can be made that Darwin represented a specific product of that same process (Browne, 1995). The European Enlightenment that spawned the Industrial Revolution generated the traditions that coalesced into the several manifestations of professional science, and it is certainly no accident that these were particularly vigorous in those areas most directly affected by the Protestant Reformation. One of the best illustrations of this is the resounding declaration of pious Protestant faith in Puritan New England that "*Philosophy* is no *Enemy,* but rather a mighty and wondrous *Incentive* to *Religion*" (Mather, 1771:1). Others have dealt with this at greater length elsewhere (Lovejoy, 1936; Merton, 1938). The full development of that theme is beyond the scope of my current presentation. I am going to suggest, however, that the currents which coalesced in British industrialism and science were generated by the Scottish Enlightenment and that Charles Darwin was very much a product of that phenomenon.

THE OUTLOOK OF THE SCOTTISH ENLIGHTENMENT

Robert K. Merton has made an eloquent case for the impact of the Protestant Reformation on the genesis of the scientific outlook (Merton, 1938). In the 16th century, Martin Luther had argued that every informed individual was competent to make judgments concerning right and wrong without specific instructions and guidance from the ordained clergy (Friedenthal, 1967). The growing faith in the competence of human decision-making capacity spread with the expansion of the areas under Protestant

control in northwest Europe. Further, the realm where individual competence was considered a relevant issue began to extend beyond matters of religious ethics to the secular realms of politics and technology. The very idea of popular democracy as a desirable or even viable form of government was one of the consequences. Of course, this had to contend with the previously established systems based on inherited status and wealth which gave more weight to certain individuals than to the average citizen.

One of the other consequences in this faith in the capability of the informed human mind to make valid decisions was the belief that the pursuit of knowledge was a good thing in and of itself and could be of material as well as spiritual benefit both individually and collectively. The Protestant Reformation under John Knox had introduced this Luther-derived outlook to Scotland in the 16th century, where it took root and flourished over the next two centuries. The "union" with England in 1707 and the collapse of "The Forty-Five"—the unsuccessful rebellion by "The Young Pretender," Charles Edward Stuart or "Bonnie Prince Charlie"—made it clear to most Scots that their future welfare lay in mastering the ways of their English neighbors to the south and turning them to their own advantage.

Eighteenth-century Scotland, then, in classic Protestant fashion, embarked upon a campaign of self-improvement. The first step was learning to speak English, and the second was in a focus on education that stressed the cultivation of those practical skills that constituted their own version of the Age of Reason, the Scottish Enlightenment. This took the form of what has variously been called "Scottish Realism," "Scottish Philosophy," or "The Scottish School of Common Sense" (Cousin, 1857; McCosh, 1875; Grave, 1960). Although various figures such as Francis Hutcheson (1694–1747), David Hume (1711–1776) and Adam Ferguson (1723–1816) can be regarded as manifestations of the Scottish Enlightenment, the principal embodiment was that exponent of the School of Common Sense, Thomas Reid (1710–1796), specifically in the views he expounded in *An Inquiry Into the Human Mind, on the Principles of Common Sense* of 1764 (Duggan, 1970).

In good Protestant manner, Reid refused to accept knowledge that was conveyed solely on the basis of constituted authority. Similarly, he did not accept the existence of innate ideas as advocated by René Descartes (1596–1650) or Bishop George Berkeley (1685–1753) on the one hand, but, on the other, he rejected the extreme skepticism of David Hume. To Reid, the existence of a real world was a "self-evident truth," and, in good Baconian fashion, this could be known through observation and experiment (Swetlitz, 1988: 78). His real, material world was a Newtonian one where there is an identifiable cause for every discernible event. That world is available through perception by the senses—induction, as Bacon used the term—after which, through analysis and abstraction—deduction, again in the Baconian sense—the knowledge of its nature is gained. This is what Reid called "common sense."

The definition was neither as simple nor as straightforward as its proponents tried to suggest. Since the self-evident is "incapable of proof, the truths of common sense have no logical antecedents" (Grave, 1960:151). Ultimately, this means that common sense in fact has to be characterized as "metaphysical belief" (Grave, 1960 p. 120). At one level, it simply reflects "good sense" as opposed to "nonsense" (Lehrer, 1989:152). Beyond that, in almost Chomskian fashion, it included the assumption of an ubiquitous aspect of human capability demonstrated by the structure of language and its universal grammatical nature (Grave, 1960). Despite the effectively a priori nature of this assumption, it was not regarded as an equivalent to one of Berkeley's pre-existing ideas. As illustrated by the universal presence of language, Reid felt that the ability to reason was a common possession of all human beings whether philosophers or peasants, that is, it was a capacity which characterized the human condition. Adding complication to this was the view that truths vouched for in the knowledge shared by a community came closer to reflecting the wisdom of God than could be the case for the judgment of a single individual. Viewed in that way, the highest manifestation could be called "*communal*

sense" (Wills, 1978:188). It was this latter form of the definition that was so influential in America (and see Thomas Paine's *Common Sense* of 1776; see Wills, 1978), and which was picked up and used by Thomas Jefferson in drafting the Declaration of Independence. In contrast, it was the version stressing the capacity to reason inherent in every individual that was stressed in practical fashion by what was to emerge when the various sciences crystallized into professional form after the end of the 18th century.

At a quasi-theological level, the roots of the Unitarianism in the northern British Isles as well as in New England in America were clearly located in Thomas Reid's Scottish Philosophy of Common Sense (Howe, 1970). The Darwins of Shrewsbury were Unitarians. Charles' father, Dr. Robert Waring Darwin, gleefully quoted the words used by his own father, Dr. Erasmus Darwin, in describing Unitarianism as "merely a featherbed to catch a falling Christian" (Browne, 1995:12). Erasmus Darwin was twitting his friend Josiah Wedgwood's drift away from the orthodox church towards secularism. At the same time that Charles Darwin began studying medicine in Edinburgh in 1825, Ralph Waldo Emerson was finishing his training at a Harvard Divinity School dominated by a Unitarian outlook and dedicated to the Common Sense of Thomas Reid (Howe, 1970; Allen, 1981). Later in the 19th century, this became secularized in the "Pragmatism" of Charles Sanders Peirce and William James in America, the inductive logic of John Stuart Mill in England, and in the Logical Positivism of the Vienna Circle in Europe (James, 1907; Williams, 1947; Buchler, 1955; Naess, 1968; Kenny, 1990; Diggins, 1994). The influence of the School of Common Sense on continuing currents of philosophy has been explicitly recognized (Woozley, 1970) to the extent that the 20th-century representatives of "English Philosophy," George Edward Moore (1879–1958) and Ludwig Wittgenstein (1889–1951), have been called the "Cambridge philosophers of common sense" (Williams, 1947:188).

Its impact on shaping political traditions in America and France has also been noted (McCosh, 1875; Bryson, 1945; Wills, 1978), as has its impact on ideas concerning education (Sloan, 1971). Finally, its role in shaping the outlook of the emergence of the systematic pursuit of science, particularly physics and chemistry, has been given specific recognition (Olson, 1975). The science of geology, in addition, had been given major impetus by the non-practicing Edinburgh physician, James Hutton (1726–1797), singled out as an exemplar of "Common Sense" among 18th-century scientists (Olson, 1975). Hutton, of course, was the major influence on the thinking of the Scottish-born geologist, Sir Charles Lyell (Wilson, 1972). Lyell, in turn, has been described as Darwin's "role model" (Browne, 1995:324). Darwin gave full credit to "Sir Charles Lyell's grand work on the Principles of Geology" (Darwin, 1859: 282; and see his tribute to Lyell in F. Darwin, 1887). He even went so far as to say that, "I always feel as if my books came half out of Lyell's brain" (quoted in Young, 1985: 84). The intellectual stance of Charles Darwin, then, is a clear-cut manifestation of the continuity of the characteristic mode of thinking of the Scottish Enlightenment.

BIOLOGICAL ANTHROPOLOGY AND 20TH CENTURY THOUGHT

While the biological sciences now largely take it for granted that Darwin's vision underlies their general approach (Dobzhansky, 1973; Alexander, 1980), there are some notable exceptions, and among these are large segments of paleontology and biological anthropology (Eldredge and Cracraft, 1980; Wiley, 1981; Groves, 1989; Rightmire, 1990; Kimbel and Martin, 1993; Stringer and Gamble, 1993; Tattersall, 1994, 1997). A look at a sampling of the latter will illustrate some of the dimensions of the ambivalence involved.

In less than five years now, the calendar millennium will indeed be with us, but I am not at all sure that the biological portion of anthropology will have actually entered it in the metaphorical sense. At the end of the previous decade, the futility of the efforts "to drag paleoanthropology 'kicking and screaming into the 20th century' " (borrowing the words the late Adlai Stevenson had used in a political context) was given explicit recognition (Brace, 1989:444), and it looks very much as though this will not happen prior to

the arrival of the 21st. To my dismay, the direction in which the field is going is expressed by the words, "We believe that Darwinism . . . is . . . a theory that has been put to the test and found false" (Nelson and Platnick, 1984:143). What has been taking place is something I have referred to as the "great leap backwards" and the reaffirmation of an outlook that is not merely pre-Darwinian but positively Thomist (Brace, 1988:133). Accompanying that, biological anthropologists who should know better have not only demonstrated an unawareness of their own intellectual past but have actually engaged in the attempt to rewrite it. The almost certain consequence of that ignorance of our history is that we shall be condemned to repeat it.

A case in point is the recent treatment of that famous symposium on "The Origin and Evolution of Man" held at the Cold Spring Harbor Laboratory on Long Island in the summer of 1950. Rather than having been an occasion where the currents of neo-Darwinian thought were brought into the anthropological cloister as its surviving participants remember, it has been described as "an attempt to consolidate and institutionalize an approach to human evolution that owed more to political conviction than to science" (Shipman, 1994:191). According to this reading of events, the upshot of that symposium was that there are some aspects of human biology "that were better left unexplored" (Shipman, 1994:190). Certainly the potential for political misuse of anthropology was recognized by the participants, but the general consensus of the meeting was the diametric opposite of that charge. This can best be illustrated by quoting from the "Concluding remarks of the chairman," Curt Stern (1950:412):

> The political implications of statements or conclusions regarding the origin and evolution of man have been in our minds again and again.
>
> Knowing the terrible harm which has grown out of misconceptions . . . there is a tendency to shy away from conceptual regions, or from terms, which might be exploited by ill-will or stupidity. I believe that science should not yield to such derived impulses. We should look for the truth wherever it can be found. We should not assume that facts do not exist because their uncritical postulation has been detrimental.

In essence, this is a restatement of the credo of the defenders of "natural theology" in the Enlightenment, a position that was elegantly articulated in 1831 in the Presidential Address to the Geological Society of London by the Woodwardian Professor of Geology at Cambridge, Adam Sedgwick (Hallam, 1983).

The same author who gave that curious rendering of the 1950 Cold Spring Harbor Symposium also managed to botch the import of the Darwinian synthesis that preceded it. Experimental geneticists were said to have focused on the role of mutation as the agent of evolutionary change to the extent that selection was regarded as "irrelevant" (Shipman, 1994:151). That may have been true of De Vries over a generation earlier, but it was most definitely not the stance of those who created the synthesis.

Continuing that undocumented assertion, the further claim is made that, "Rather than pointing to natural selection as the main or only motor producing evolutionary change, the geneticists became entranced with a concept known as *genetic drift*" (Shipman, 1994:151). It is true that one of the contributors to the synthesis, Sewall Wright, did offer genetic drift as a secondary and less important mechanism (Wright, 1931, 1943, 1946), but virtually all of the figures involved including Wright stressed natural selection as the principal driving force (Fisher, 1930; Wright, 1931, 1932, 1980, 1988; Dobzhansky, 1937; Huxley, 1940; Mayr, 1942; Simpson, 1944). One of the more important of them, Sir Ronald A. Fisher, spent the rest of his life denouncing Sewall Wright for even suggesting that genetic drift was a possibility and dogmatically maintaining that natural selection is the sole and sufficient mechanism (Fisher and Ford, 1950). The dogmatism of this stance has sometimes been attributed to the neo-Darwinian synthesis as a whole and properly criticized as "hyperselectionism" (Gould and Lewontin, 1979). For a full recounting of the history of the development of these matters, there is no better rendition than the magisterial survey by Ernst Mayr (1982). Predictably, however, biological anthropology has reacted to that treatment in characteristically pre-Darwinian fashion (Tattersall, 1984).

THE MISPERCEPTION OF CHARLES DARWIN

If this version of the evolutionary synthesis can serve to illustrate just how far off the track contemporary biological anthropology can stray, the picture it presents of the beginnings of evolutionary biology and the nature of its founder, Charles Darwin, is even more of a travesty. Consider this: "Often lionized as a great thinker, Darwin plodded along on his subject like an uncertain little man who has gotten hold of an idea too big for him" (Trinkaus and Shipman, 1992:33). Portraying him as a witless clod, the claim has been put forth that "he was simply blotting paper, soaking up life's ink" (Shipman, 1994:23). The same set of points was made over a generation ago by the literary critic, historian, and irascible curmudgeon Jacques Barzun, who declared that "Darwin was a great assembler of facts and a poor joiner of ideas" (Barzun, 1958:74 [revised from 1941]; and see the similar stance taken by Himmelfarb, 1959). These in turn fed off Darwin's own self-deprecatory comment that "I have no great quickness of apprehension or wit" (CR Darwin, 1887:82), and that he owed his success to "industry in observing and collecting facts" (CR Darwin, 1887:72).

Actually, tucked away in the midst of his apologia, Darwin in fact mounted a modest defense of his "fair share of invention as well as common sense" (CR Darwin, 1887:86), and supported this in his statement in *The Origin*, as in his letter to his publisher, that his whole volume constituted "one long argument" (Darwin, 1859:459; Paston, 1932:170; Mayr, 1991). As Mayr has properly cautioned in regard to Darwin's "Autobiography," it "was written with that exaggerated Victorian modesty that induced Darwin to belittle his own achievements and the value of his education" (Mayr, 1982:394). The most recent biographical treatment has referred to his Autobiography as "an exercise in camouflage" and "a smoke screen almost as effective as if no records had been left at all" (Browne, 1995:x–xii). In Mayr's assessment, "biographers all too readily have tended to accept his words at face value, particularly where Darwin made disparaging remarks about his own abilities, and then wondered how such an uneducated dullard could have become the architect of perhaps the greatest intellectual revolution of all time" (Mayr, 1982:394).

Even subsequent defenders of a Darwinian vision of evolution have often described him in condescending fashion. In C.D. Darlington's treatment, for example, he is depicted as "a rather quaint naturalist with an eye for detail and a mind which became confused when engaging in theory" (Darlington, 1959; Ghiselin, 1969; Reed, 1978). Right in line with this, the recent assessment of the origins of evolutionary thought as seen from the perspective of biological anthropology is that Darwin's ideas would never have survived if it had not been for their presentation by Thomas Henry Huxley, "the man more brilliant than Darwin" (Trinkaus and Shipman, 1992:21; and note Barzun's assessment of Huxley as having been "a far keener thinker," Barzun, 1958:74). Continuing in the same vein, another voice representing current biological anthropology has asserted that "Darwin . . . must have been every bit as dull in person as his prose suggests he was" (Harpending, 1996:99). On the other hand, one American visitor, writing from Down on July 12, 1872, described his pleasure in conversation with "the best brain in Europe" by declaring that "Darwin was as simple and jovial as a boy, at dinner," continuing that "I never met a more simple, happy man" (Brace, 1894:321). His most recent biographer concurs: "Clearly he was not nearly as dull as he maintained" (Browne, 1995:xi).

To add some perspective, Huxley privately commented that *The Origin* was "one of the hardest books to understand thoroughly that I know of" (Huxley, 1901: vol. 2, p. 190). The most recent full-scale treatment of Huxley's intellectual contribution observed that he "never fully came to terms either with Darwin's 'dynamic' attitude towards nature or his 'pragmatic' conception of the logic of science" (Di Gregorio, 1984:199). Huxley clearly had a preference for a view in which change occurred by sudden and unexaminable means in the mode of the subsequent saltationists and more recent proponents of punctuated equilibria (Eldredge and Gould,

1972; Di Gregorio, 1984:197). These trends reach their extreme in the more uncompromising promotion of "cladistic" logic (Wiley, 1981; and see the skepticism in the accounts of Brace, 1988; Kellog, 1988; and Dennett, 1995; and in the hilarious spoof by Queller, 1995). As with his intellectual progeny, Huxley evidently was more comfortable with a world of order as opposed to a world of process (Rehbock, 1985:172).

It seems more clear than ever in retrospect that Darwin would have come to be regarded as the giant that he was even had there been no Huxley. Huxley, however, could never have achieved the stature for which he is remembered if there had been no Darwin. Study after study continues to uncover further dimensions of Darwin's intellectual sophistication, and it would be to our benefit to heed the warning offered in the first full treatment of Darwin's philosophical competence: "The reader would do well to beware of a number of recent books which attempt to discredit Darwin's intellect or character" (Ghiselin, 1969:28). A still more recent assessment from the realm of professional philosophy has declared, "If I were to give an award for the single best idea anyone has ever had, I'd give it to Darwin ahead of Newton and Einstein and everyone else. In a single stroke, the idea of evolution by natural selection unified the realm of life, meaning, and purpose with the realm of space and time, cause and effect, mechanism and physical law" (Dennett, 1995:21).

Cautions against the persistent efforts at denigration, past and present, include the demonstration that "the myth seems to have been already current that Darwin was a mere naturalist and an amasser of facts—a man of limited intellect and small capacity for abstract thought" (Ghiselin, 1969:136). That "myth" stems from Darwin's own times. His publisher, John Murray, sent the manuscript of the *Life and Letters of Charles Darwin* edited by his son, Francis Darwin, to the Duke of Argyll for review. The Duke, who had been one of the pallbearers at Darwin's funeral in Westminster Abbey, wrote back that while Darwin "was the greatest observer that ever lived," he was also remarkable for "the extraordinary defectiveness of his philosophical faculties" (quoted in Paston, 1932:169–170).

Although even so sophisticated a student of evolutionary biology as the late George Gaylord Simpson made the claim that "Darwin was no philosopher" (Simpson, 1964: 50), the converse was stated in convincing fashion at the same time (Mayr, 1964), and the subsequently published full-length treatment of his command of philosophy concluded that he was "a century ahead of his time" in that field, and that "Those who condemn Darwin as incompetent in philosophy do so either from ignorance of his ideas, or because they, personally, would prefer to reject his conclusions" (Ghiselin, 1969:159). While this nicely places the Duke of Argyll, Simpson clearly does not fit in either of those categories, and it would seem that his assessment was really more a reflection of his own lack of background in philosophy. As we shall see, Darwin's success was the result of an almost unique example of the combination of both scientific and philosophical sophistication.

In similar fashion, Darwin's expository style has been denigrated starting with his own contemporaries and continuing right up to the present. In Huxley's words, "exposition is not Darwin's forte and his English is sometimes wonderful"—where "wonderful" is something "to be wondered at" (Huxley letter to Sir Michael Foster in 1888, quoted in Huxley, 1901: vol. 2, p. 203; and see Barzun, 1958). Darwin himself contributed to this assessment in his autobiography, saying "I have as much difficulty as ever in expressing myself clearly and concisely" (Darwin, 1887:80). This continues to be accepted at face value in some quarters, as for example in the scornful reference to "Darwin's diffuse style of illustrating his thesis by anecdote after anecdote, one rambling natural history after another" (Shipman, 1994:92).

In addition, he is accused of exhibiting the "amateurish foible" of being "careless about footnotes and proper attributions" (Shipman, 1994:92)—this by an author who got both the page and the quote wrong for Darwin's famous line in *The Origin* that "Light will be thrown on the origin of man

and his history" (Darwin, 1859:488).[1] As an example of Darwin's supposed carelessness, he is charged with having made an "interesting slip" in the 1858 letter to Lyell in which he referred to the "sketch" of his major thesis as having been written out in 1842 (Shipman, 1994:31). This is considered a "slip" because the author asserts it as fact that Darwin's "sketch" was written in 1844. Presumably his mention of the supposedly erroneous earlier date was a demonstration of his willingness to distort the facts in order to stake a claim to intellectual priority (Shipman, 1994).

Again, the carelessness is actually on the part of the accuser since the truth of the matter is that Darwin did write his "Sketch" in 1842. The "Sketch" of June 1842, running to thirty-five pencil-written pages, was the basis of what was expanded into the "Essay" of the summer of 1844 (F Darwin, 1887, vol. 1, p. 68). At 230 pages, that "Essay" could actually count as a book, and it contained many of the phrases later used in the *Origin*. Long after his death, both the "Sketch" and the "Essay" were eventually published in the first decade of our own waning century along with a valuable "Introduction" by Darwin's son Francis (Darwin, 1909). This was all subsequently reprinted in 1958 with the addition of the paper by Alfred Russel Wallace that had been read on his behalf at the Linnean Society of London in July of 1858. These are collected in a volume edited by Sir Gavin de Beer, who also contributed a Preface that reflected on a century of the developments in evolutionary thought set in motion by Darwin's extraordinary initial contribution (de Beer, 1958).

Darwin's detractors, anthropological and other, have tended to identify several specific areas of presumed deficiency in each general aspect of treatment—for example his supposed weaknesses in scholarship, philosophy, and writing. When specialists in each of these realms have examined Darwin's performance, it is interesting to note the extraordinarily high marks they have generally given him. These realms are not absolutely independent of each other, and a certain inevitable cross-over will take place in the consideration of each. Since his performance can only be assessed in terms of what he wrote, it is reasonable to start with the assessment of Darwin as a writer.

DARWIN AS A WRITER

Consistent with the repeated grumbles he articulated about his struggles with written expression, his daughter, Henrietta Litchfield, noted that "He did not write with ease," and "He corrected a great deal" (F Darwin, 1887: vol. 1, p. 130). However, her brother added another perspective when he stated that their father's writing was, "above all things, direct and clear" and "characterized by a simplicity bordering on naïveté, and in its absence of pretence" (F Darwin, 1887: vol. 1, p. 131). I well remember my own reaction on first reading *The Origin* when I was in high school almost exactly fifty years ago. Instead of finding it "difficult" or abstruse, it was so transparently clear that I felt a certain sense of disappointment. I had anticipated that some sort of revelatory initiation would have been my reward after a long hard struggle. Instead, the book was simply the voice of common sense articulating in chatty and friendly fashion what seemed patently obvious, and I was at a loss then to understand what all the fuss was about. Of course, it was not obvious before he said it, and it is a measure of his genius that he was able to generalize about the complex interrelationships of the natural world in a fashion that made them seem almost self-evident to his readers.

More than one analyst has noted that "He used everyday terminology to convey precise and definite meanings with elegance and clarity" (Ghiselin, 1969:189). Even more than that, "no major works of science have ever been concerned more profoundly or in a more revolutionary way with Man and Nature than Darwin's *The Descent of Man* and *The Origin of Species*," and, "unlike almost all other major seminal works in science, they were quite accessible in language and ideas to the general lay educated public" (Leatherdale, 1983:6). As many of us have learned through painful experience, rendering the complexities and mechanisms of the

[1]Shipman (1994:23) cites Darwin's words as having been located on page 449, and renders the quote as it had been modified for the subsequent editions where he had expanded it to read, "Much light . . . "

natural world in written form is not an easy thing to do. Consequently it should be perfectly obvious why he felt it necessary to correct a great deal and why he commented on the difficulties he had in being clear and concise. Good writing is hard work, and, since Darwin's writing is extraordinarily good, it should hardly come as a surprise to discover that he struggled to make it so.

In line with those who have chosen to portray Darwin as a narrow and limited figure who was unaware of the richness and dimensions of his cultural contemporaries, the author of the Introduction to the 1968 edition of *The Origin* opined, "Presumably he would have approved no more of the works of his contemporary, George Eliot, than she did of *The Origin*" (Burrow, 1968: 12). A more recent appraisal, however, "controverts both these assumptions" (Beer, 1983: 266). In contrast to the claim that he was only interested in "light" fiction where the heroine was pretty and there was a happy ending (Burrow, 1968:12), the record shows that he was fully conversant with both contemporary philosophy and literature. Early in 1859, even before he delivered the manuscript of *The Origin* to his publisher in London, Darwin had purchased Eliot's *Adam Bede* as soon as it appeared. In the book-lists of his Notebook, he gave it "the rarest of comments": "Excellent" (Beer, 1983:266).

George Eliot (Marian Evans Lewes) on her part, after some initial reservations, became similarly impressed with *The Origin*. Her husband, George Henry Lewes, had been given an advance copy to review for *Blackwood's* (the book's formal date of publication was November 24, 1859). In her journal entry for November 23, 1859, Eliot noted "We began Darwin's work on 'The Origin of Species' tonight. It seems not to be well written: though full of interesting matter, it is not impressive for want of luminous and orderly presentation" (quoted in Haight, 1954: vol. 3, p. 214). Her opinion changed as she became more familiar with it. In her journal for November 24, 1859, she wrote: "A divine day. I walked out and Mrs. Congreve joined me. Then music, 'Arabian Nights,' and Darwin" (quoted in Cross, 1885, Vol. 2, p. 105). Eventually she concluded that Darwin had contributed a "step towards brave clearness and honesty" and that *The Origin* "will have a great effect in the scientific world" (letter to Madame Bodichon, December 5, 1859, quoted in Cross, 1885: Vol. 2, p. 108). Not only was she right in that prediction, but it went on to have an enormous impact on the literary world as well—including her own contributions as for example in *Middlemarch* (Levine, 1986). Her only complaint, in direct contrast to that of the "blotting paper" school of thought, was that it was "sadly wanting in illustrative facts" (Cross, 1885: Vol. 2, p. 108).

In fact, when Darwin had submitted his manuscript, he apologized to his publisher, John Murray, because it was "without references to authorities and without long catalogues of facts" (quoted in Paston, 1932:168), which is why he persisted in referring to a 500 page book as an "Abstract." He had intended to include the word "Abstract" in the title, but Murray objected and it was dropped, although it remained in the text (Burrow, 1968). Despite its dearth of extensive references and documentation, no one ever questioned the accuracy of the examples Darwin chose to cite or the fact that an enormous amount of observation lay behind the case he was presenting. His reputation as a thoroughly competent biologist had been solidly established by his exhaustive four-volume treatment of the Cirrepedia—the barnacles—of the world (Darwin, 1851a, 1851b, 1854a, 1854b). Although the claim has been made that his "proliferation of other works reeks of avoidance and self-protectiveness" (Shipman, 1994:26), both Joseph Dalton Hooker and Thomas Henry Huxley later wrote to Francis Darwin that his father's barnacle work was one of the wisest moves that he had made (Hyman, 1959). Recently, the British moral philosopher, Mary Midgley, has concurred by declaring that the eight years of his barnacle work was "no mere displacement activity but an admirable tactic" (Midgley, 1995:1197, agreeing with the treatment by Darwin's most recent biographer: Browne, 1995).

Among those who have realized the effectiveness of his rhetorical skills, one appraiser, using "The methods . . . of modern literary criticism" (Hyman, 1959:70), has claimed that *The Origin* can be regarded as

"a dramatic poem of a special sort" (Hyman, 1959:26). In fact, despite the denigration that Darwin took "no delight in words as such and had little feeling for literature" (Burrow, 1968:12), his reading lists for the years from the late 1830s through the 1850s show him ranging from Shakespeare and Montaigne through Sir Walter Scott and Thomas Carlyle. He acknowledged his fondness for Byron, Coleridge, Gray, Shelley and the historical plays of Shakespeare. Among the books he kept in his cabin on the *Beagle* besides Humboldt's *Personal Narrative of Travels* and Lyell's *Principles of Geology* was Milton's blank-verse epic, *Paradise Lost* (Bölsche, 1906; Browne, 1995). The volume of Milton's poetry was "the one book he never left behind when he set out on his isolated land-journeys from the *Beagle*" (Beer, 1983: 31–32). One can even hear Miltonian echoes in passages such as the one in which he evokes the metaphor of the "tangled bank" (Hyman 1959), and in the sonorous last sentence of *The Origin* which starts "There is a grandeur in this view of life . . ." (Darwin, 1859:490).

The writer who likened *The Origin* to poetry even went so far as to note that the language sometimes "gets quite Biblical" and could constitute "something like a sacred writing" (Hyman, 1959:34). Whether or not it warrants that apotheosis, another comparably qualified critic has declared it to be the "summa of the 'literature of fact' of the nineteenth century" (White, 1976:43). The same analyst generalized even further in concluding that *The Origin* "must rank as a classic in any list of the great monuments of literature" (White, 1976:37). Of course, denigrations of Darwin's work date right back to his own time, and his publisher's editor, Whitwell Elwin, spoke of his works as being "full of puerilities, and the productions of an inferior, not at all of a master mind" (quoted in Paston, 1932:270).

Closer to the present, the eminent historian, critic, and curmudgeon, Jacques Barzun, became almost choleric at the idea that some have treated *The Origin* as "a masterpiece of English literature," regarding this as "an opinion which can only come from revelation by faith and not from the experience of reading the work" (Barzun, 1958:79). He concluded that "Darwin does not belong with the great thinkers of mankind" (Barzun, 1958:84), and that *The Origin* "was greater as an event than as a book" (Barzun, 1958:30). That reaction bears a striking resemblance to the way in which Darwin was treated by his French critics starting in the latter part of the 19th century, and, coming from Barzun almost a century later, it is more an indication of the continuity of French intellectual traditions than of an attempt to deal with the issues themselves. Barzun, in fact, can count as a living manifestation of the themes of French anti-evolutionary thought explored at length by Stebbins (1974) and Boesiger (1980).

DARWIN'S USE OF METAPHOR

Adding to its power, as many critics have remarked, is Darwin's extraordinary and skillful use of metaphor. One of these has noted that, "The exuberantly metaphorical drive of the language of *The Origin* was proper to its topic" (Beer, 1983:38); and this, in the words of another, "is one of the reasons for the unusually wide and powerful effect of Darwin on general ideas and literature" (Leatherdale, 1983:4). The very use of the term "natural selection" had the effect of reifying "Nature" and has led to the skeptical rhetorical query, "does nature select?" (Young, 1985:79). Furthermore, there are metaphorical implications in his use of terms such as "struggle," "chance," "accident" and many more. It was a technique that he had adopted from Lyell, and, as Lyell had used the "metaphor of decipherment" (Beer, 1983: 44) to uncover the "history of the globe" (Lyell, 1830:88), Darwin applied it in the attempt to gain insight into the history of the living forms that have been earth's denizens. Another literary commentator mined the *Poetics* for Aristotle's claim that "to be a master of metaphor . . . is . . . a sign of genius, since a good metaphor implies an intuitive perception of the similarity in dissimilars" (Hyman, 1959:33). "By this criterion," he declared, "Darwin displayed genius as morphologist and metaphorist alike" (Hyman, 1959:33), and he noted further that Darwin's approach was "Perhaps not so far as it might seem from Proust's comparable venture in comprehending the duration of past time" (Hyman, 1959:34).

Darwin presented his case in narrative fashion, and some readers ranging from his own contemporaries right on up to the present day objected to his story-telling style (Shipman, 1994). Not properly scientific, was the feeling of those who took their science rather too seriously. As our postmodern world approaches the millennium and the intent of an author or a text has been demoted to a position of lesser status than that of how it can be read (Kendrick, 1995), surely Charles Darwin has earned his ultimate vindication. Umberto Eco's latest tour-de-force "reminds us of the authoritarianism of narrative itself, the eternal dictator who is the story teller" (Kelly, 1995:9). In retrospect, it is abundantly clear that Darwin knew full well that "Only by telling a story can you tell if an idea is valid" (Kelly, 1995:9). Darwin told story after story, and whatever the ambiguities that emerge from attempts at deconstruction, the overarching point towards which they were all directed remains unquestioned and unrefuted.

Darwin's use of metaphor, however, was not just a matter of giving his writing the power to engage the attention of his readers, although it also had that effect. It has been argued that what impelled him to choose that form of presentation was that he had reason to think that one of his intellectual models, Sir John F.W. Herschel, would not accept the unadorned framework of his argument as constituting an acceptable manifestation of scientific logic. Herschel was an astronomer, a philosopher of science, and the author of the *Preliminary Discourse on the Study of Natural Philosophy*, a work that had a profound influence on Darwin, who read it during his last year at Cambridge and again in 1838 (Herschel, 1830; Ruse, 1975). Since the nature of the available biological data did not lend itself to the precise form of quantification demanded by Herschel's vision of the logic of science, Darwin clothed "the bare logical skeleton of his argument . . . with the plausible and relevant imagery of his metaphors and analogies. This was never a question of abandoning science for mere rhetorical fiction and fancy; Darwin's metaphors did a full scientific job" (Manier, 1978:156). In Herschel's eyes, however, Darwin failed to accomplish his purpose, and that redoubtable figure is quoted as having denigrated natural selection as "the law of higgledy-piggeldy" (quoted in F Darwin, 1887: Vol. 2, p. 241).

While Darwin suggested that it might have been possible to present his case without resorting to the use of metaphor, at least one analyst has argued that this could not have been done: "I hold a view of the scientific uses of metaphor which denies that Darwin's metaphorical expressions could have been replaced by completely literal statements setting forth the core of his theory" (Manier, 1978:169–170). At the base of this argument is the suggestion that, "At least two key concepts, population and chance, were not readily expressible and manageable within the context of that scientific discourse which was the common and uncontested possession of Darwin and his contemporaries" (Manier, 1978:70). Darwin understood full well that populations were not mere aggregates but in fact were structured groups that had to be considered in the context of the co-adaptation of organism and environment. In his perception of chance, he recognized the impossibility of reducing causal chains to single sources. This could be dealt with metaphorically, but could not profitably be reduced to the simple equations preferred by formal logicians which is one reason why Herschel found Darwin's argument so vexing (Manier, 1978: 70).

Far from being a mindless "laundry-list," Darwin's seminal volume "almost shimmers with metaphysical promise" (Durant, 1983: 466). The implications were clearly understood by his Christian opponents such as Bishop Samuel Wilberforce, who was the anonymous author of the review of Darwin's *Origin* appearing in the July issue of *The Quarterly Review*, the main intellectual periodical produced by Darwin's own publisher, John Murray ([Wilberforce, 1860]; Paston, 1932). Darwin's former teacher at Cambridge and the person who had introduced him to geological field work in 1831 (Rudwick, 1974), the devout biblical literalist Adam Sedgwick, had already made some of the same objections at the meetings of the Cambridge Philosophical Society and in his comments on *The Origin* in *The Spectator* in

March of the same year (Sedgwick, 1860; Burkhardt, 71). Neither critic was characterized by the "ignorance" or "lack of understanding" with which they have often been charged any more than are those of our contemporaries who now deny the value of Darwin's contributions. Sedgwick and Wilberforce, however, along with others such as Herschel and William Whewell, then Master of Trinity College at Cambridge and author of the three-volume *History of the Inductive Sciences* (Whewell, 1837), were seriously offended by Darwin's failure to incorporate "final causes" into his explanatory scheme—that is, his failure to depict a specific role for their Christian God.

DARWIN AND THE PHILOSOPHY OF SCIENCE

It will be instructive to consider a bit further one of Sedgwick's complaints because that can give us a little insight into some of the assumptions concerning the philosophy of science that continue to hamper the appraisal of Darwin's accomplishment. It was Sedgwick's claim that Darwin's work had not followed proper inductive procedures and had in fact started by assuming what was to be proven (Sedgwick, 1860; Nelkin, 1977). There is a wondrous irony in the realization that, despite a century and more of accusations that Darwin was nothing more than a fact-gathering machine, his severest contemporary critics had in fact charged that his principal fault lay in his failure to confine his exposition to the theory-neutral compiling of data which they held to be the appropriate manifestation of scientific behavior.

According to the generally accepted outlook of Darwin's contemporaries, the proper practice of science proceeded in an Aristotelian "inductive-deductive" fashion. This had been affirmed by Roger Bacon at Oxford in the 13th century and reasserted late in the 16th century by Sir Francis Bacon at Cambridge as the currents of the Reformation engaged English intellectual life (Losee, 1972). This then came to be regarded as the accepted way of doing things during the time when the practice of science took on a life of its own in the Enlightenment and subsequently. Compatible with the traditions of Enlightenment-style "natural theology," Darwin included quotes from both Sir Francis Bacon and from Whewell's Bridgewater Treatise as epigraphs facing the title page of his *Origin* (the latter being from Whewell, 1833). Later, in the Autobiography posthumously included in his *Life and Letters*, he asserted that he had always "worked on true Baconian principles, and without any theory collected facts on a wholesale scale" (quoted in Ghiselin, 1969:4; and in Beer, 1983:82).

Those words were right in line with what was expected for the time, but there has been a belated but growing realization that they do not constitute an accurate description of what he actually did. That "realization," however, is structured by the verbalizations of the philosophical orthodoxy of our own times, and these may well have added further aspects of confusion. For example, one reassessment of the Victorian scientific outlook has stated that, "Darwin, like other scientists of his day, gave much lip service to 'induction,' and such hypocrisy has long obscured the real nature of scientific discovery" (Ghiselin, 1969:35). To label a recognition of the role of "induction" as "hypocrisy," however, implies an acceptance of the claim by the late Sir Karl Popper that "induction is a myth" and that "no 'inductive logic' exists" (Popper, 1978:148). In Popper's view, "induction was a myth which had been exploded by Hume" (Popper, 1978:80), and science can only proceed through attempts at falsification or refutation of hypotheses by the application of deductive logic (Popper, 1978:79).

For those who have accepted this at face value, Darwin's "long, involved inductive argument" (Hull, 1967:335) was at odds with what currently is perceived as the only proper—that is, the "hypothetico-deductive"—mode of scientific behavior (Hull, 1973:35). In contrast, however, at least one recent appraisal of Darwin's understanding of the philosophy of science has concluded that "Darwin applied, rigorously and consistently, the modern hypothetico-deductive scientific method" (Ghiselin, 1969:4). That in fact was the approach advocated by those voices of Cambridge-style "common sense" philosophy, Herschel and Whewell (Ruse, 1975:166,180). Furthermore, in "sophisti-

cated modernistic" fashion, his approach involved the development of "a testable hypothesis" which he then proceeded to confront "with as many potentially falsifying cases as he could" (Reed, 1978:213).

Interestingly enough, it was a lawyer who first clearly perceived the technique of presentation that Darwin had used to promote his argument. His publisher, John Murray, had taken the manuscript sight unseen at the recommendation of Sir Charles Lyell. He was completely baffled by what he read and felt that Darwin's theory was "as absurd as though one should contemplate a fruitful union of a poker and a rabbit" (quoted in Haynes, 1916:232). His chief editor, Whitwell Elwin, had gotten Lyell to suggest trimming the theory and concentrating on Darwin's own observations on pigeons. Elwin felt that this was "an admirable suggestion. Everyone is interested in pigeons" (quoted in Paston, 1932:172). To get another opinion, he asked a legal friend, George Pollock, to read it. Pollock did so and recommended that it deserved to be published although it was "probably beyond the comprehension of any living scientist" (Haynes, 1916:232). In appreciation of the way in which Darwin developed his argument, Pollock noted that he "had brilliantly surmounted the formidable obstacles which he was honest enough to put in his own path" (quoted in Haynes, 1916:232). In essence, he had done his best at attempting falsification in full Popperian fashion. Belatedly, it has finally been realized that "his theory was necessarily hypothetical rather than traditionally inductive" (Beer, 1983:51).

While this may make the current analysts somewhat more happy with the status of Darwin's intellectual credibility, this is really more a comment on current philosophical dogma than it is on what Darwin actually did. Again, in diametric opposition to the assumptions of the "blotting paper" school, the assessment of his approach as indicated by the Notebooks that he generated between 1837 and 1839, a full 20 years before the appearance of *The Origin*, has concluded that "every factual inquiry was initiated and understood within a general theoretical framework" and that, from what they contain, it is not possible to reconstruct whether "there was ever a point in his actual research program where he proceeded on 'pure Baconian principles' " (Manier, 1978: 116). Of course, this does not speak to his outlook over the previous five years when, as a scientific neophyte, he was circling the world on the *Beagle*. Even then, however, right from the time of his pre-*Beagle* field trip with Sedgwick in Wales, his geological work was basically involved with the testing of hypotheses (Browne, 1995). That was clearly evident during his first solo effort at geologizing on St. Jago in the Cape Verde Islands, and continued to be abundantly true for his following work in the Andes and subsequently (Browne, 1995:294).

In 1860, a year after the appearance of his magnum opus, he wrote to Sir Charles Lyell that, "Without the making of theories, I am convinced there would be no observations" (in F Darwin, 1887: Vol. 2, p. 315). Later in his Autobiography he reflected, "My mind seems to have become a kind of machine for grinding general laws out of large collections of facts"; and Francis, in his "Reminiscences" of his father, commented that "it was as though he were charged with theorising power ready to flow into any channel on the slightest disturbance, so that no fact, however small, could avoid releasing a stream of theory" (quoted in Beer, 1983:79). Writing to Henry Fawcett in 1861, Darwin declared, "How odd it is that anyone should not see that all observation must be for or against some view if it is to be of any service" (quoted by Gould, 1992:2).

An hypothesis can be regarded as "a provisional truth, presenting itself provisionally as fiction, and seeking ultimately to find confirmation" (Beer, 1983:80). No one realized that more acutely than Darwin, and it is this that accounts for the countless stories and scenarios that he related in *The Origin* and in his other books. The eventual perception of this aspect of Darwin's approach nearly a century after his death can be shown in the words, "Darwin spent well over twenty years trying to refute his hypothesis of natural selection, and he was more immersed in the relevant problems and data

than anyone before or since. The best argument for the irrefutability of his theory is his failure; indeed, it is the only argument for its irrefutability" (Reed, 1978:217).

When one takes all of this into account and adds it to the record of what he actually did, his whole outlook takes on a strikingly modern aspect (Ghiselin, 1969; Manier, 1978; Beer, 1983). I am going to go further, however, and suggest that Darwin was actually a major step ahead of where much of the philosophy of science now finds itself as the 20th century comes to a close. The impact of the late Sir Karl Popper has been to denigrate induction and promote deduction to a position where it counts as the sole logical activity associated with the pursuit of science. Strict deductivism, however, "is a thesis of an intrinsically *frivolous* kind" since it cannot add to what is already known (Stove, 1982:99). In essence, it is tautology. The practice of strictly deductive procedures for the first millennium after the establishment of Christianity has led to this being characterized as "a period of depressing intellectual stagnation" (Mayr, 1982:308). Darwin, in his gentle non-dogmatic way, declared that he was always skeptical of initial hypotheses and always ready to give one up when facts could be shown to be in opposition. He concluded, "this has naturally led me to distrust greatly deductive reasoning . . ." (CR Darwin, 1887: 83).

Now that I have raised the specter of the "frivolous," I cannot resist the opportunity to quote from the oeuvre of I. Wright Drivell, that indubitably cross cousin of I. Doolittle Wright and a fellow colleague in the Department of Homopathic Anthropopoetics at the University of Southern North Dakota at Hoople, an institution better known for the illuminating products of the current occupant of its General Electric chair, among them *The Definitive Biography of P.D.Q. Bach (1807–1742)?* (Schickele, 1976). Suitably couched in the Scottish meter of Robert Burns, Drivell's effusion is part of a longer opus that he called "Punctured Cladomania" and which first appeared in Brace (1988: 133). As the reader can easily see, it is a pretty characteristic bit of Drivell:

"Hypothetico-deductive;"
Jargon phrase that's so seductive;
Denies what might be called inductive
For the view,
The known can never be productive
Of the new.

But science viewed in such a way
Is nothing more than idle play;
For though the sun arose today,
Yet to our sorrow,
Deduction cannot let us say
'Twill rise tomorrow.

As early as his Notebooks of 1838, Darwin had declared his dedication to the "hypothetical-deductive" approach advocated by Herschel and Whewell, but first he noted that it was necessary "to establish a point as a probability by induction" and then test it deductively (F Darwin, 1887: vol. 1, p. 93, Vol. 2, pp. 79, 286; Ghiselin, 1969; Manier, 1978:157). Interestingly enough, Huxley, quite in contrast to Sedgwick's appraisal, specifically lauded Darwin for precisely this approach in his review of *The Origin*, and noted that Darwin had proceeded "in exact accordance with the rule laid down by Mr. [John Stewart] Mill" ([Huxley], 1860:309). Although it was unsigned, as was the case with Wilberforce's review (1860), the identity of the author in both cases was universally known. Ironically, Darwin may never have read Mill's *System of Logic, Ratiocinative and Inductive . . . and the Methods of Scientific Investigation* (1843) before framing the structure of his own argument (Mill, 1843; Manier, 1978).

When we put Darwin's approach into the context of the history of philosophy, it is apparent that his vision of induction anticipated by the better part of a century that of the founder of Pragmatism, the American philosopher Charles Sanders Peirce, who, in contrast to Popper, started with the declaration that "all our knowledge may be said to rest upon *observed facts*" (in Buchler, 1955: 150). C.D. Broad once noted that although Inductive Reasoning may be regarded as the

"scandal of Philosophy," it has "long been the glory of Science" (Broad, 1926:67). If the continuing current of Popperism still denies that induction has a legitimate role to play, it has provided no guidelines on how to acquire the information used in framing hypotheses (Brace, 1988). While some suggest that science proceeds by selection among randomly generated hypotheses, the skeptical appraiser will reply that hypotheses do not come out of "randomizers" (Midgley, 1982:126).

Although Darwin had transcended the outlook which stressed the claim that order in the world constitutes proof for the existence of a Designer as had been defended by Archdeacon Paley (Paley, 1802; and see Darwin's rejection of this on page 87 of the edition of his Autobiography with the original omissions restored, published by Barlow, 1958), he had been much taken with the way in which Paley marshaled his case, and he adopted that technique to defend his "transmutation theory" (Manier, 1978:164). As has been realized, "Paley's form of argument, cumulative rather than deductive, was very much Darwin's own in *The Origin*" (Burrow, 1968:58; and see Barlow, 1958). Rather than confining himself to strict falsification in approved Popperian fashion, Darwin further concentrated on corroboration in the manner of his 18th century Anglican predecessor, the Reverend Thomas Bayes, an approach now recognized by the designation "Bayesian statistical inference" (Iversen, 1984). Popper did allow a role for corroboration (Salmon, 1968), but it was based on a treatment of probability that was opposite to that commonly used in science: that is, the recommendation that one should focus on the most unlikely hypotheses because they are the easiest to refute (Popper, 1959, 1963). Darwin, however, followed in the tradition of what has been called "Bayes' Theorem" and attempted to provide "a more accurate and explicit portrayal of the interaction between assumptions, data, and conclusions than is evident in the superficially simple syllogisms of falsificationist logic" (Fisher, 1987: 328).

Most practicing scientists would happily agree with the observation by the philosopher-physicist, Gerald Holton, that, in science, there are two meaningful types of statements: "namely, propositions concerning empirical matters of fact (which ultimately boil down to meter readings) and propositions concerning logic and mathematics (which ultimately boil down to tautologies)" (Holton, 1973:21). Whether induction is considered at the level of meter readings as Holton indicates or "the laws of probability" of John Maynard Keynes (Keynes, 1921; Broad, 1922), Darwin was indeed using an inductive/deductive approach quite in the manner that characterizes the best of science being done at the present time. The most recent appraisal of Darwin's standing from the point of view of current philosophy fully concurs (Dennett, 1995).

DARWIN AND THE HISTORY OF SCIENCE

The roots of that approach are indeed Baconian and right in the tradition of the Enlightenment and Natural Theology (Paley, 1802), but the course by which it was transmitted into the various branches of science as these became professionalized was fundamentally shaped by the Scottish Enlightenment. What has been referred to as "Scottish Philosophy," the Scottish "School of Common Sense," or "Scottish Realism" (McCosh, 1875) has been recognized as the source for the professionalization of the "hard sciences" (Olson, 1975). While it has not been stressed previously, an equally valid case can be made that Scottish Realism was of comparable importance for the development of professional geology via Sir Charles Lyell on the one hand and in the development of professional biology on the other, and that the medium for the transmission of its outlook to the latter was none other than Charles Darwin.

Both his father and his grandfather had received their medical training in Edinburgh. Grandfather Erasmus' subsequent friendships and activities all showed a clear derivation from the outlook of the Scottish Enlightenment (Schofield, 1963), and the industrial Midlands with which their families and fortunes were associated owed more to that perception of the world than it did to

the tides of Romanticism that had begun to make an increasing impact on London and the more urban southern portions of England (Rehbock, 1984). Charles Darwin himself spent the years 1825–1827 in Edinburgh, and, although much is usually made of his failure to benefit from the medical curriculum with which he was nominally associated, he had become involved in the study of natural history and, under the influence of the zoologist Dr. Robert Edmund Grant, he was an active participant in the Plinian Society before which he made his first scientific presentation on March 27, 1827 (Gruber, 1974; Browne, 1995).

The stamp of Scottish Realism was evident in his outlook for the rest of his life (Manier, 1978:194). Darwin was suspicious of the extreme skepticism of David Hume and the Cartesian body-mind dualism of Dugald Stewart, and his own approach to such matters was somewhat more in line with that of the good Scottish Realist, John Fleming (1785–1857), whose two-volume *Philosophy of Zoology* (1822) in his library was "exhaustively annotated" in Darwin's hand (Manier, 1978:60). It should be noted that Fleming's "philosophy" comes a lot closer to what we would now call the "science" of zoology, although he did deal with issues that we now tend to regard as more characteristic of philosophy (Bryson, 1945). Fleming's treatment of "*Truth*," for example, is right in line with the realist views of Thomas Reid and his successor, Dugald Stewart (Fleming, 1822).

In line with the tendency to use the term "philosophy" to include what is now meant by "science," Captain FitzRoy gave Darwin the nickname "Philos.," standing for "Ship's Philosopher," which was enthusiastically adopted by the crew of the *Beagle* (Browne, 1995). The very word "scientist" was only coined by William Whewell three years after the *Beagle* left port on her literally revolution-making voyage (Sheets-Pyenson, 1984). Given the fundamental importance of Charles Darwin for the basic outlook of the biological sciences ever since, he should count as every bit as important for the transmission of the outlook of the Scottish Enlightenment into professional biology as Dalton was for professional chemistry and Kelvin for professional physics (Cardwell, 1968; Olson, 1975).

DARWIN IN BIOLOGY

Now, while I have described Darwin's outlook as of "fundamental importance" for the biological sciences, it was not automatically so (Bowler, 1968). Even during his own lifetime, while his "importance" was never in question and the concept of evolution was elevated to the status of a permanent issue in the minds of the public as well as in science, the mechanism that he had offered to account for evolution was rejected by the majority of his readers both lay and professional. By the end of the century, the only thing that Darwin's scientific readers held in common was "their rejection of creationism" (Mayr, 1991:99), and the "firm belief" that evolution had not only taken place but that it had been accomplished "by natural means" (Mayr, 1991:100). Few were willing to grant that those means referred to natural selection as Darwin had described it (for example, Osborn, 1894). By the time the first third of the 20th century had elapsed, that stance had hardened to the point where Darwin's mechanism was considered to have been an interesting but unworkable intellectual gambit that warranted a footnote in the history of ideas but needed to be quietly put aside while the real mechanics were worked out (Nordenskiöld, 1928; Singer, 1931).

The retrospective discovery of Mendel's work as the field of genetics was established during the first part of the century did not change the way most scientists perceived the nature of Darwin's insights. The nature and reality of genetic shuffling and transmission could be tested and verified in the laboratory, but selection could not push the range of variation in a given species beyond the limits already observed (Morgan, 1916). All of that changed, however, when Hermann J. Muller, who was then at the University of Texas, took some of his fruit flies to a local doctor's office in 1926 and got them irradiated with X-rays (Muller, 1927; Pauly, 1987). In one shot, he got more mutations than had been found by all the other *Drosophila* workers together over the previous 15 years. Almost immediately, it was realized that Darwin's faith that inherited vari-

ants would constantly provide the material on which natural selection could operate to produce evolutionary change was a faith fully justified. Not long after that, J.B.S. Haldane concluded that mutations constituted exactly what Darwin had postulated as "the raw material on which selection acts" to produce organic evolution (Haldane, 1929: 444).

The stage was now set, and the next decade saw the reinstitution of a fully Darwinian perspective as the "Synthetic Theory of Evolution"—sometimes called the "Neo-Darwinian Theory of Evolution." It was "synthetic" because it integrated the perspectives of genetics, field and laboratory biology, and paleontology. The contributors included Haldane, Ronald A. Fisher, Sewall Wright, Theodosius Dobzhansky, Julian Huxley, Ernst Mayr and George Gaylord Simpson to name them roughly in the order of the dates of their initial contributions. As the only surviving member of that extraordinary group, Mayr has told its story in splendid fashion (Mayr, 1982).

From that time on, Darwin's principal ideas have continued to remain at the core of the thinking of evolutionary biology. His own genetic theory of "pangenesis" and his flirtation with the inheritance of acquired characteristics have been quietly discarded, but, consistent with the way he phrased it at the end of the "Introduction" to all the editions of *The Origin*, "Natural Selection" continues to be regarded as "the main but not exclusive means of modification" driving the course of organic evolution (Darwin, 1859:6). Inevitably, there have been major additions and further theoretical elaborations.

The world of molecular biology has enormously expanded our horizons. Among the most significant additions it has been able to provide was the demonstration of the implications of the structure of DNA—deoxyribonucleic acid—the basic stuff of heredity (Watson and Crick, 1953). This not only has enabled us to understand how the genetic material could duplicate itself in cell division and from generation to generation, but it also has allowed us to understand the atomic and molecular mechanics of exactly how the genetic blueprint operates to construct a tangible organism—a phenotype—from its basic chemical constituents (Anfinsen, 1959). Among the changes in our perceptions that this understanding has produced is a heightened awareness of the different roles of the adaptive and non-adaptive portions of both the genotype and the phenotype (Nei, 1987).

Again, as we look back, Darwin clearly understood this where the phenotype was concerned, and expressed its significance with a clarity that has yet to be surpassed. Over the past several decades, the discovery by molecular biologists of non-adaptive parts of organic structure has led to the development of a movement that has sometimes been labeled "non-Darwinian" evolution (King and Jukes, 1969). Darwin, however, had clearly recognized the difference in significance of adaptive and non-adaptive parts of organisms. In his own words, "adaptive characters, although of the utmost importance to the welfare of the being, are almost valueless to the systematist" (Darwin, 1859: 427). Conversely, he recognized that "as a general rule . . . the less any part of the organisation is concerned with special habits, the more important it becomes for classification" (Darwin, 1859:414). In these phrases, he identified the differences in the problems faced by students of adaptation and students of classification with a clarity that has seldom been equaled since that time. Since the molecular focus on the distinction between adaptive and non-adaptive features can simply be regarded as "an extension of the synthetic theory of evolution," the label non-Darwinian is "misleading" and would better be simply called the "neutralist theory" and dealt with as Darwin had outlined it in the first place (Ayala, 1974:693).

Beyond the world opened up by the techniques of molecular biology, but in part made possible by that, the wealth of biological dimensions disclosed by genetic research has forced us to take account of realms that could not have been dealt with given what was available to Darwin. It was Darwin's insight that selection works at the level of the individual (Mayr, 1992), and, with that perception, he did not follow Wallace's espousal of group selection (Wallace, 1864;

Gould, 1980). However, now that we can deal with processes at the level of the gene (the "replicator" of Dawkins, 1976)—a concept not available to Darwin—it is possible to conceptualize more than a single realm where selection can operate. To deal with the differences in selection working on the gene, the individual, or at a more inclusive populational unit, the terms "level" and "vehicle" have been used (Wilson and Sober, 1994), although there are reasons for preferring a less restrictive term such as "domain" (Williams, 1992; Brace, 1994). Another kind of complication is added when relationships are reckoned in terms of "inclusive fitness" and "kin selection" (Hamilton, 1964; Wilson, 1975). In each instance, however, the logic applied is essentially what Darwin had used to deal with selection operating on the individual, and this is still the main focus of attention in contemporary evolutionary biology.

As most of the productive professionals in the business acknowledge, the biological sciences today derive in large measure from the outlook established by Charles Darwin starting in the middle years of the 19th century. Darwin, however sui generis he may seem, did not spring full-blown from an intellectual vacuum. As was true for those who can be credited with establishing the canons of professional scholarship in physics, chemistry and geology, his intellectual style was firmly rooted in the traditions of the Scottish Enlightenment of the previous century (Merton, 1938). Those roots in turn were derived from the spreading outlook of the Protestant Reformation, where it was assumed that the human mind was capable of investigating given issues, assembling the available evidence, and coming to an understanding, not just of what was right and what was not, but of how the world works in general (White, 1896; Becker, 1932; and in narrow application, Olson, 1975). In essence, it is the outlook of professional science. It takes nothing away from the phenomenal genius of Charles Darwin to recognize him as the conduit by which this outlook was transmitted into what has become professional biology. One can only hope that, in time, this will come to be recognized in professional anthropology as well.

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